PLANNING OF RAIN WATER HARVESTING & CASE STUDIES

By

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❑ Need:

- High Urbanization Growth
- Climate Changes
- High fall in Ground Water Table
- Increased water demand of Industry & Housing

These demand alternate source for water supply

Or

Say Develop the system which is self sustainable specially for water requirement

RAIN / FLOOD WATER HARVESTING CAN BE ONE OF THE BEST

Nos. of Technology are available for Recharging based on empirical approach

New products for strainer in PVC & Stainless Steel have been introduced by few companies

Feedback on design and performance has lead to strong feelings that system is not successful nor environmentally safe.

Recommended Approach For Recharging Aquifer / Rainwater Harvesting using Terrace Runoff:

DATA REQUIRED:

1) Runoff from Terrace / Roof:

a) Area: _____ sq.m.

b) Strom intensity average: _____ m / hr

c) Runoff maximum / available (average): _____ cu.m. / hr

d) Feasible detention of water during storm period: ___ cu.m.

2) Drainage of Surrounding Area:

a) Natural drainage of Rain / Flood water.

b) Location of nearer storm drain with its discharge capacity.

(e.g. Strom drain on Ghoddod Road has 4 m^3/sec capacity and the inflow from Indoor Stadium like structure is 10 m^3/sec or more. Hydraulics of drain, flood is reversal, spreading local rain water floods along drain / road).

a) Local flood levels & flow directions to be record.

3) Borehole Log (Soil Profile):

a) Soil Stratification
b) Depth of Water Table
c) Depth & width of pervious sand strata (SM / SW), aquifer (B)
d) Depth & width of next impervious strata
e) Permeability properties of strata: k_1, k_2 etc. to decide strainer / applicable condition of confined or unconfined aquifer
f) Strata with hint on k_h, k_v ratio.
(e.g. k_v for SM soil at Katargam Zone was 10^{-3} m/sec where as field pumping test shows 10^{-2} m/sec.)
g) Radius of influence zone for the recharge bore, (R) (For Surat sand strata it can be 30 to 50 m)

4) Available information for Recharge System:

a) Bore,

b) Casing,

c) Strainer,

d) Filter,

e) Transit storage tank etc.

e.g. Drilling dia. 100 mm to 1500 mm (2a) or Making wells of 2 to 3 m dia. is feasible or not !

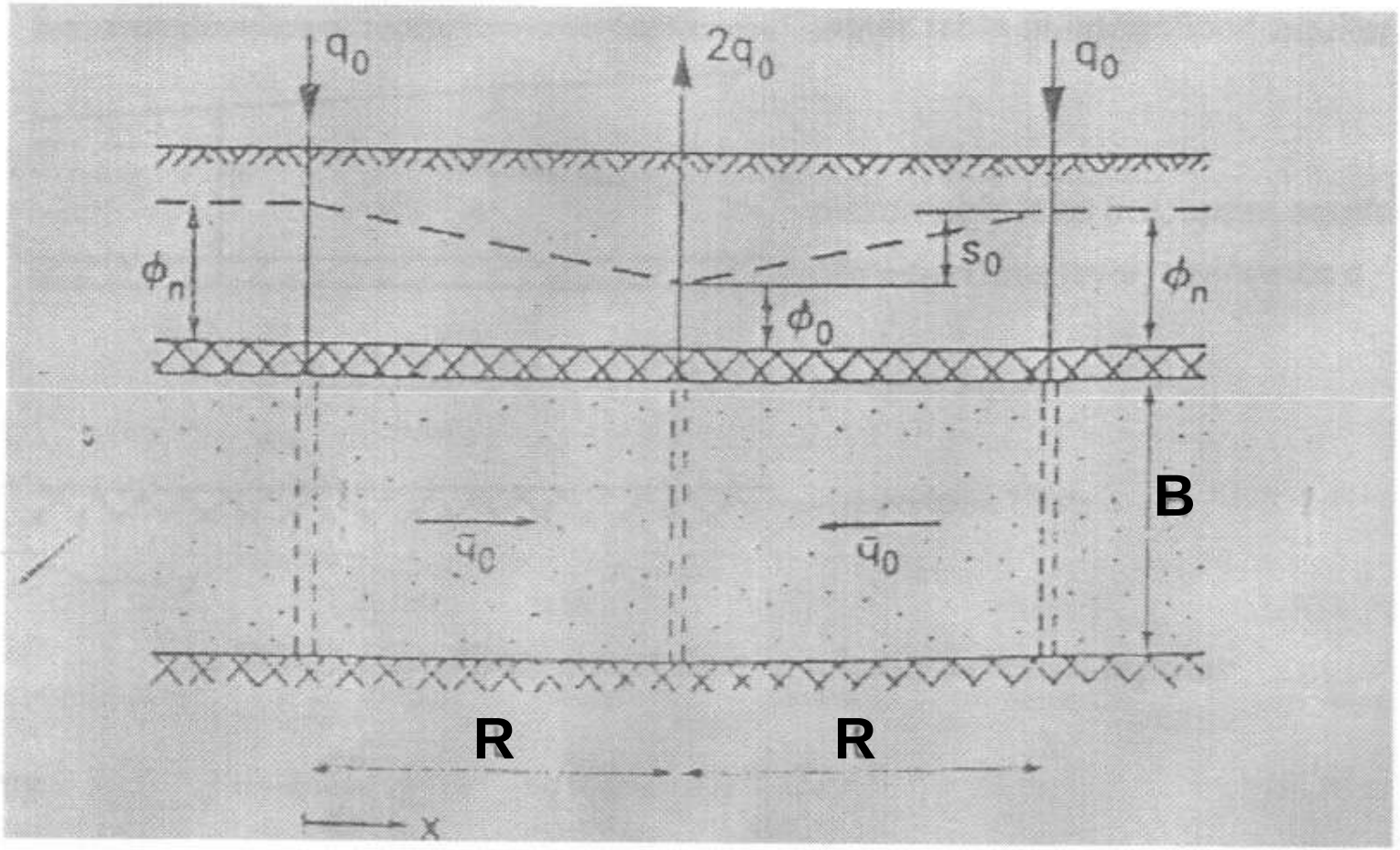


Fig. 2.1. Artificial recharge by fully penetrating wells in a confined artesian aquifer

Source: *Pratima A. Patel, 2nd Progress Seminar, Asst Prof, SCET, Surat*

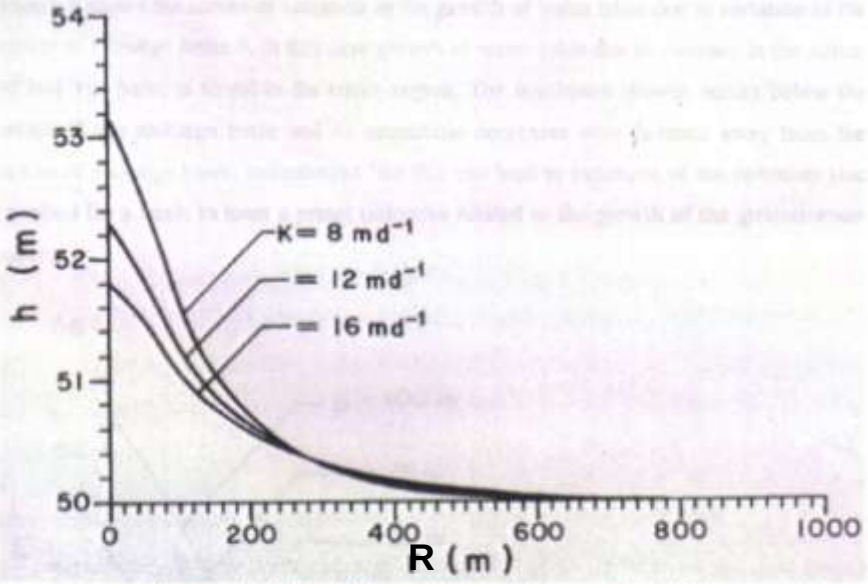


Figure – 7 : Water-table profiles for different values of K.

A comparison of water-table profiles for different values of hydraulic conductivity, ***K*** is presented in (Figure 7) to see the effect of variation in the ***K*** value on the growth of the water-table. It can be seen from the figure that an increase in the ***K*** values causes reduction in the growth of water-table in regions below and adjacent to the recharge basin. However, simultaneously an increase in the growth of water-table occurs in the farther region.

This is because for larger value of ***K*** the spreading of ground-water away from the recharge basin would be relatively faster.

Source: *Pratima A. Patel, 2nd Progress Seminar, Asst Prof, SCET, Surat*

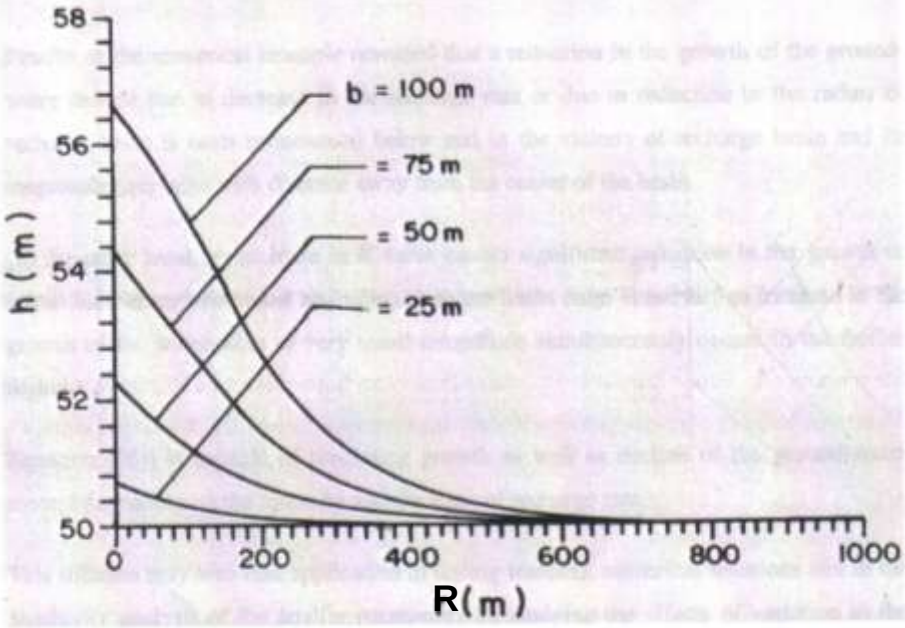


Figure – 8 : Water-table profiles for different values of **b.**

Figure 8 shows the nature of variation in the growth of water table due to variation in the radius of recharge basin ***b***. In this case growth of water-table due to increase in the radius of recharge basin is found in the entire region. The maximum growth occurs below the center of the recharge basin and its magnitude decreases with distance away from the center of recharge basin. Information like this can lead to estimates of the optimum size required for a basin to meet a preset objective related to the growth of the ground-water mound.

Source: *Pratima A. Patel, 2nd Progress Seminar, Asst Prof, SCET, Surat*

CASE STUDIES

Garden, Vareli

Recharging solves recurring floor settlement at Garden Vareli.

1. Garden Vareli sheds 10 - 15 (2003).

2. Recurring damage to floor and west wing attributed to changes in moisture content of CH expansive soil below plinth fill. (Fig. 1)

   Water logging by rain, swelling in monsoon and drying in summer.

3. Shed rain fall runoff 200 m^3/day. Time between consecutive showers 24 hrs.

   Recharge system of well with metal, gravel, sand filter layers suggested by consultants around 10 m deep well did not function. (Fig. 2)

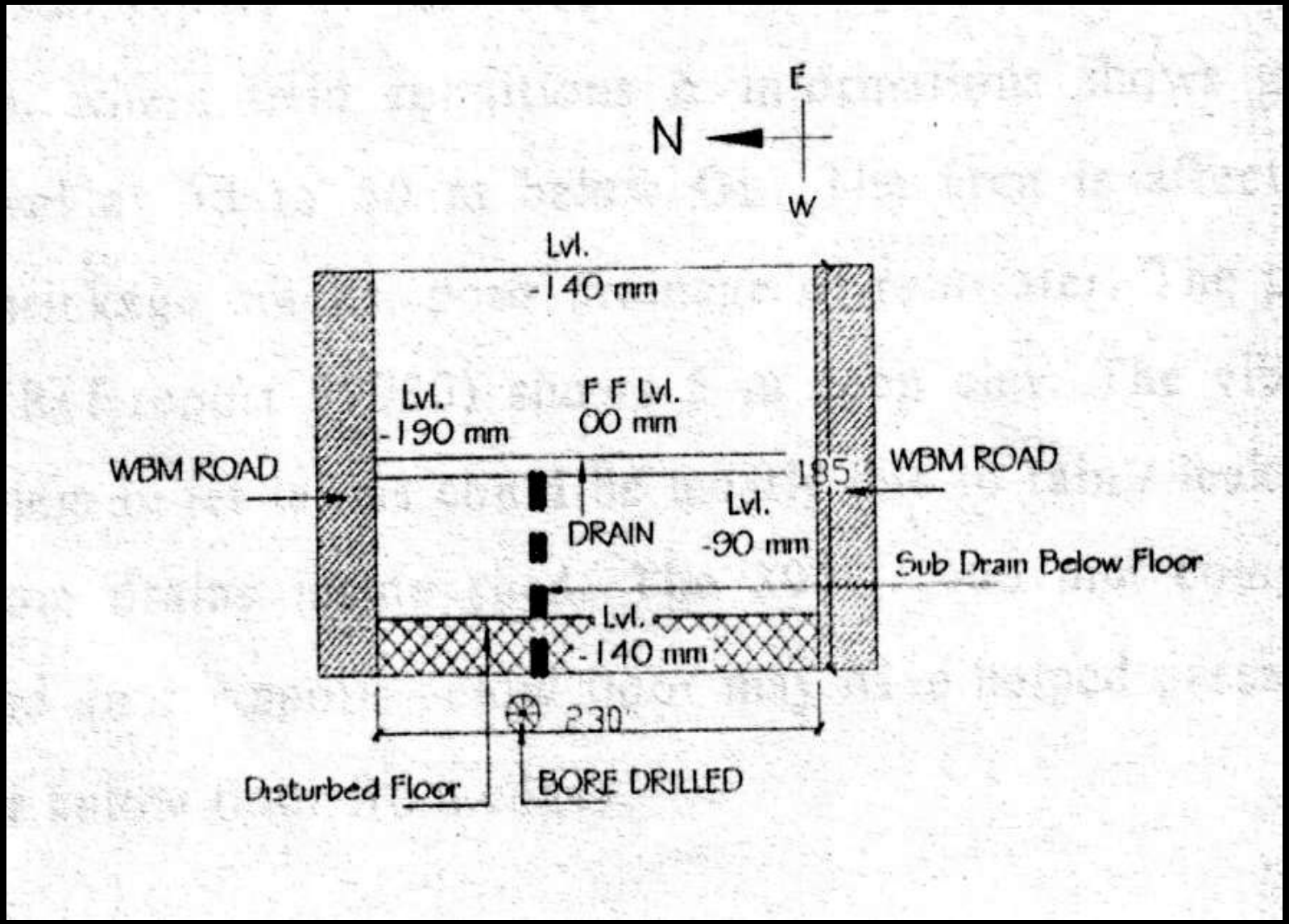
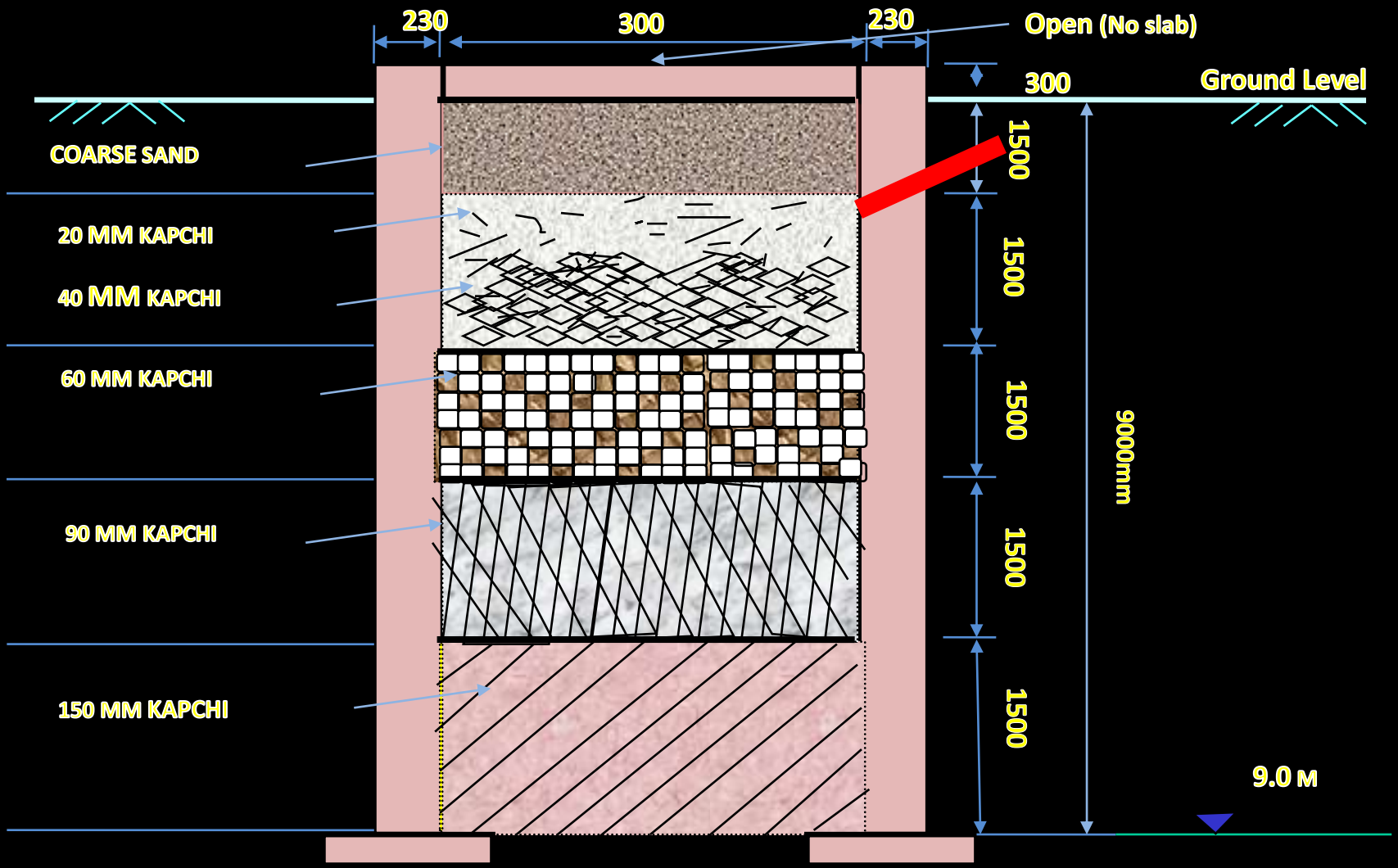


Fig. 1: Plan showing damages in Shed 10



CLINT: M/S GRADEN VARELI LTD - VARELI

Fig. 2: Recharge system of well with metal, gravel, sand filter layers

4. Proposed system Fig. 3 by speaker:

   Source of water bores 50 to 70 m deep (RL (-) 25 m to (-) 30 m)

   Water used from ground bores by industry 43,000 m^3/year.

   Proposed reservoir 30,000 m^3 (4 m deep) with recharge 4 bores: 2 m^3/hr minimum x 24 hrs x 50 rainy days = 2,400 m^3/year per bore for partial harvesting

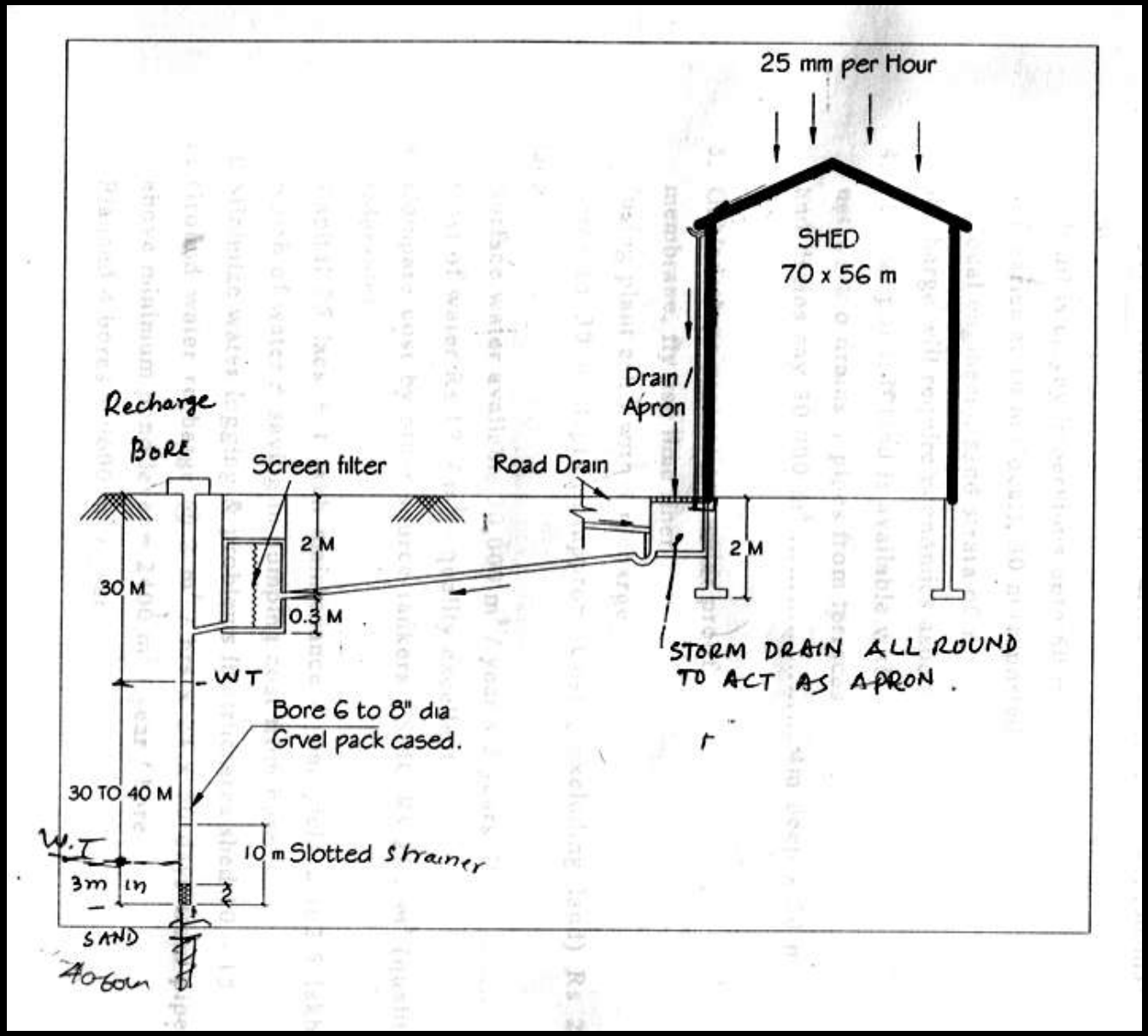


Fig. 3: Recharge system as proposed

5. Filed Trial:

9” dia. bore with strainer below 50 m (water table), 3 m in sand. Actual flow reported by test 11 m^3/hr. 10 m^3/hr x 24 hrs x 50 rainy days from roof of shed 15 = 12,000 m^3/season. The same could be placed in proposed reservoir as well for charging even after rains.

The industry will replenish the water pumped out and service for longer period.

6. Problem of shed of vibrations and recurring damage to floor.

   Jet looms 1200 CPS, acceleration vertical 3 to 5 m/sec^2, maximum displacement = 0.05 mm, amplitude 0.025 mm (Dynamic state equivalent of 0.1 g). Amplitude permissible 0.06 mm, no wetting and drying of foundation, CH soil,

   Fig. 4 using 9” wall cutoff 1.2 m deep all around. Reconstruct floor as per sketch (A), Lime Fly ash mortar ramp.

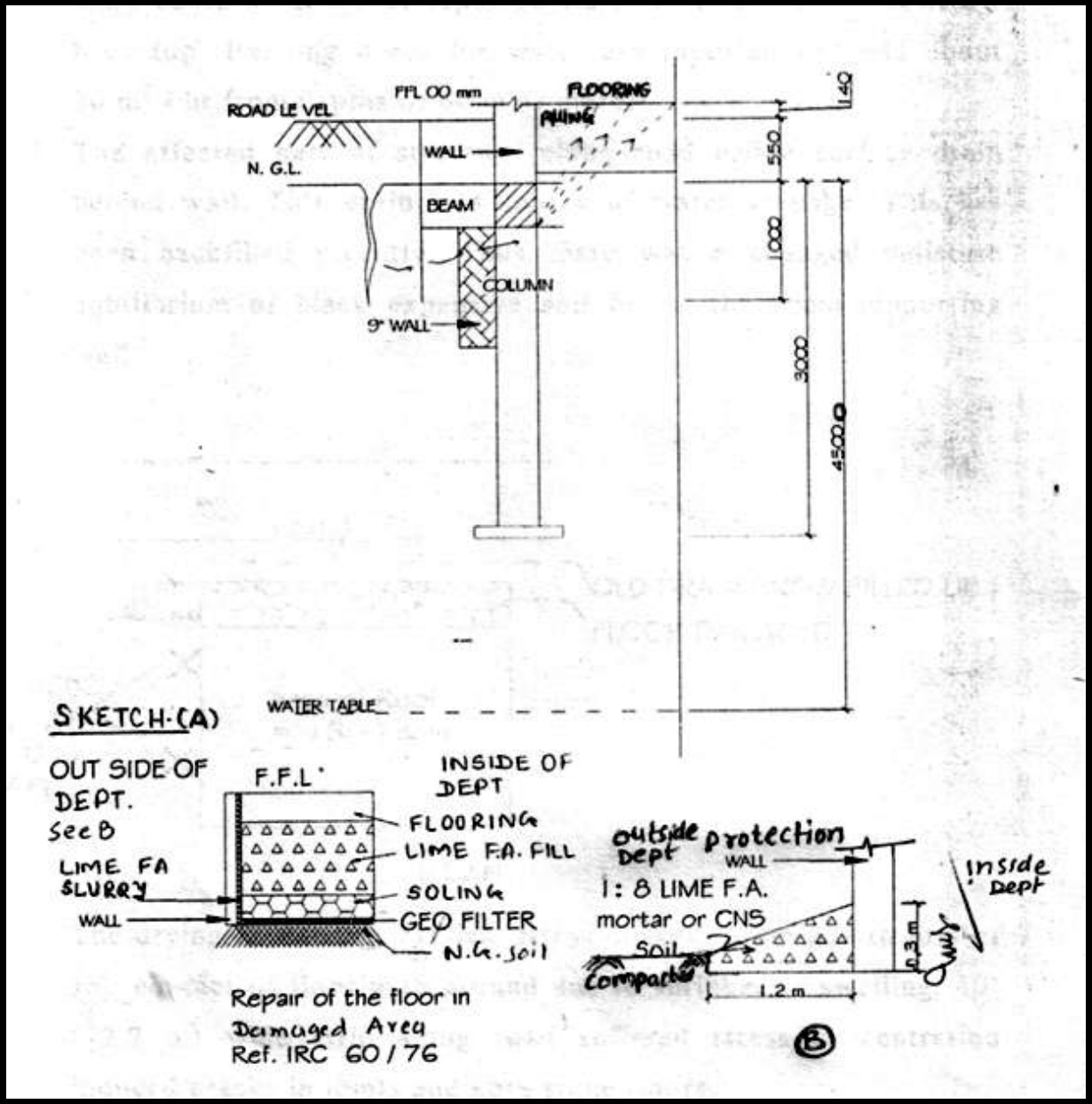


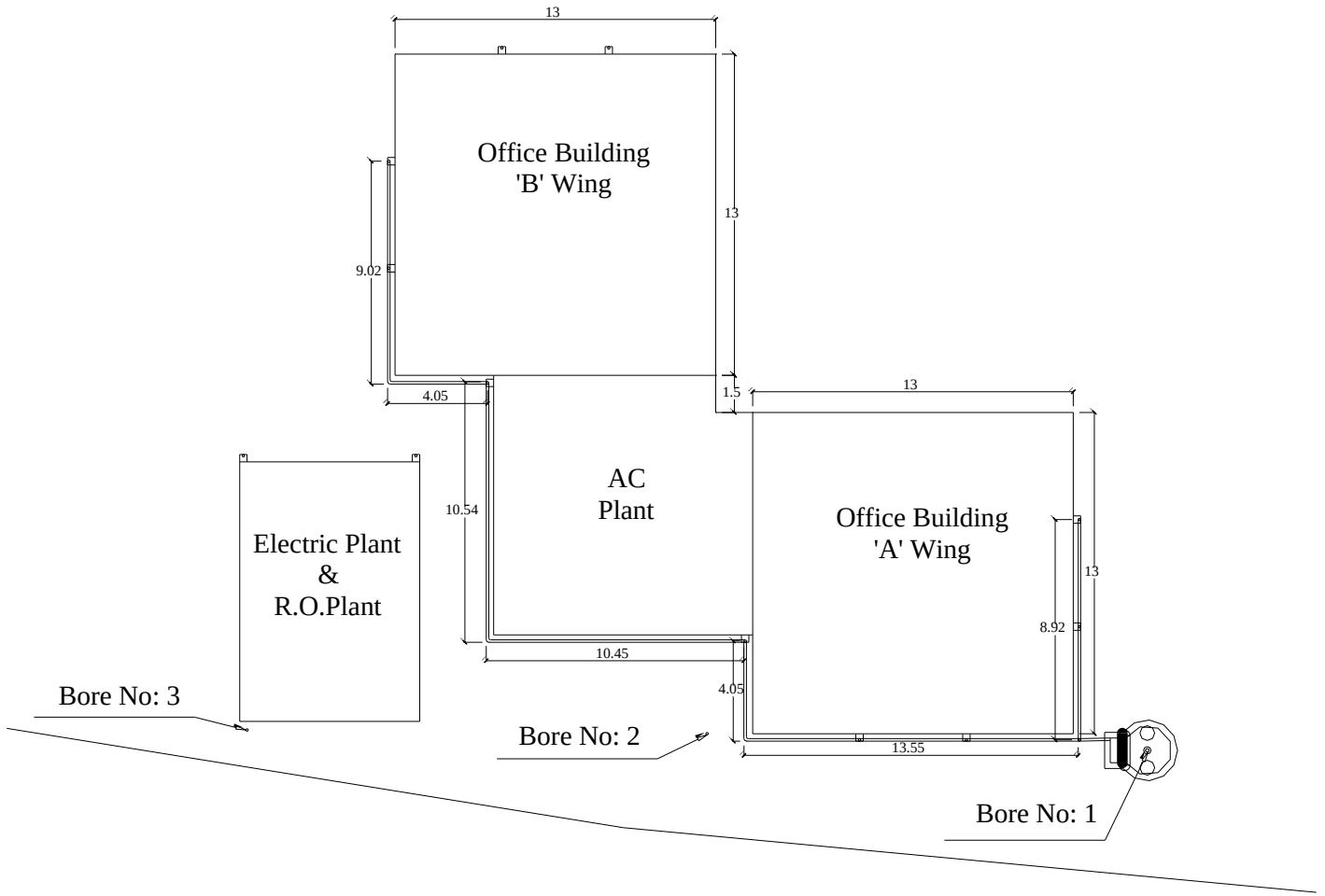
Fig. 4: Floor protection treatment

GUJARAT GAS COMPANY ADAJAN, SURAT

Recharging solves the problem of rainwater flooding at Gujarat Gas Company.

Gujarat Gas Co. Ltd, Adajan Premises:

- Total Plot Area = 10,000 sq.m
- Builtup area = 4,800 sq.m
- Plot area flooded every monsoon with small amount of rainfall
- Rain water harvesting provides the solution with utilization of existing dead bore and few new bores.



Scale: NTS

MDD/506/ 35 / Fig. 2
EFGE Consultant
Dr. M. D. Desai
Tele Fax: 2225686

Fig. 2: Plan showing Existing Structres & Bores With Proposed Recharging system. (Bore - 1)

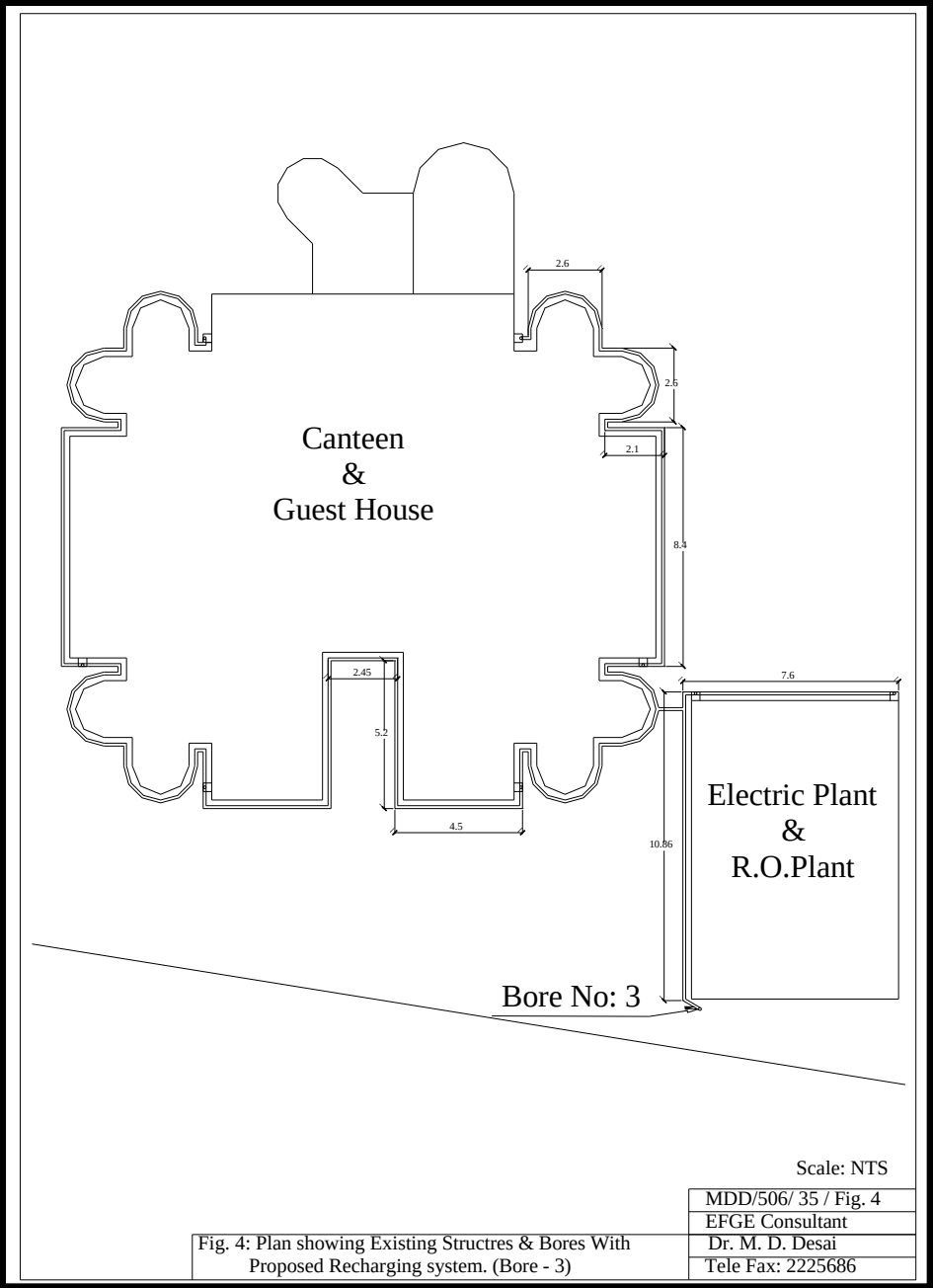


Fig. 4: Plan showing Existing Structres & Bores With Proposed Recharging system. (Bore - 3)

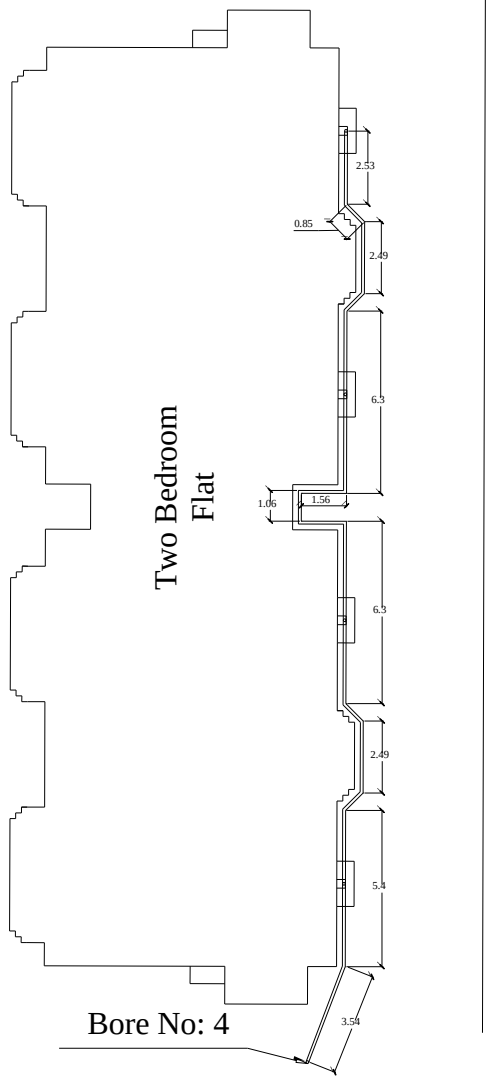


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Fig. 5: Plan showing Existing Structres & Bores With Proposed Recharging system. (Bore - 4)

MDD/506/ 35 / Fig. 5
EFGE Consultant
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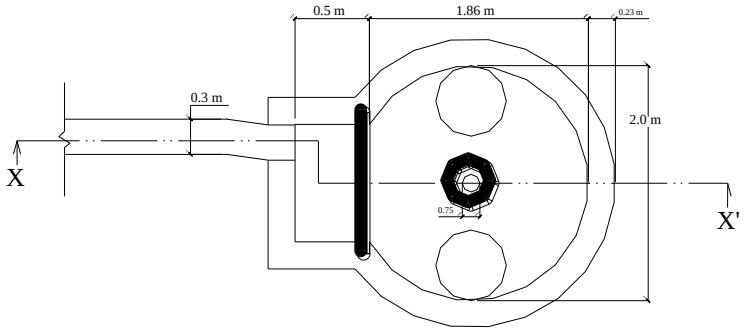
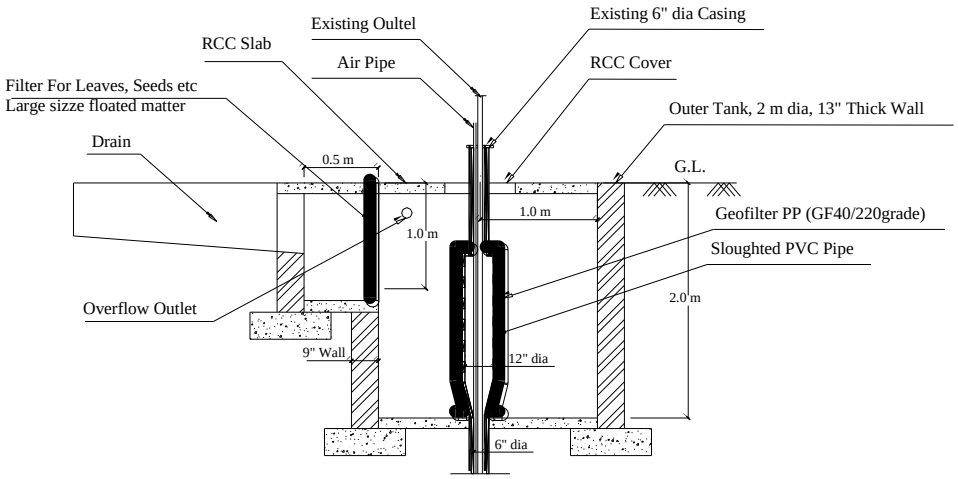


Plan



Section X - X'

Scale: NTS

MDD/506/35/ Fig. 3
EFGE Consultant
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Fig. 3: Plan & Section showing Proposed Recharging system.

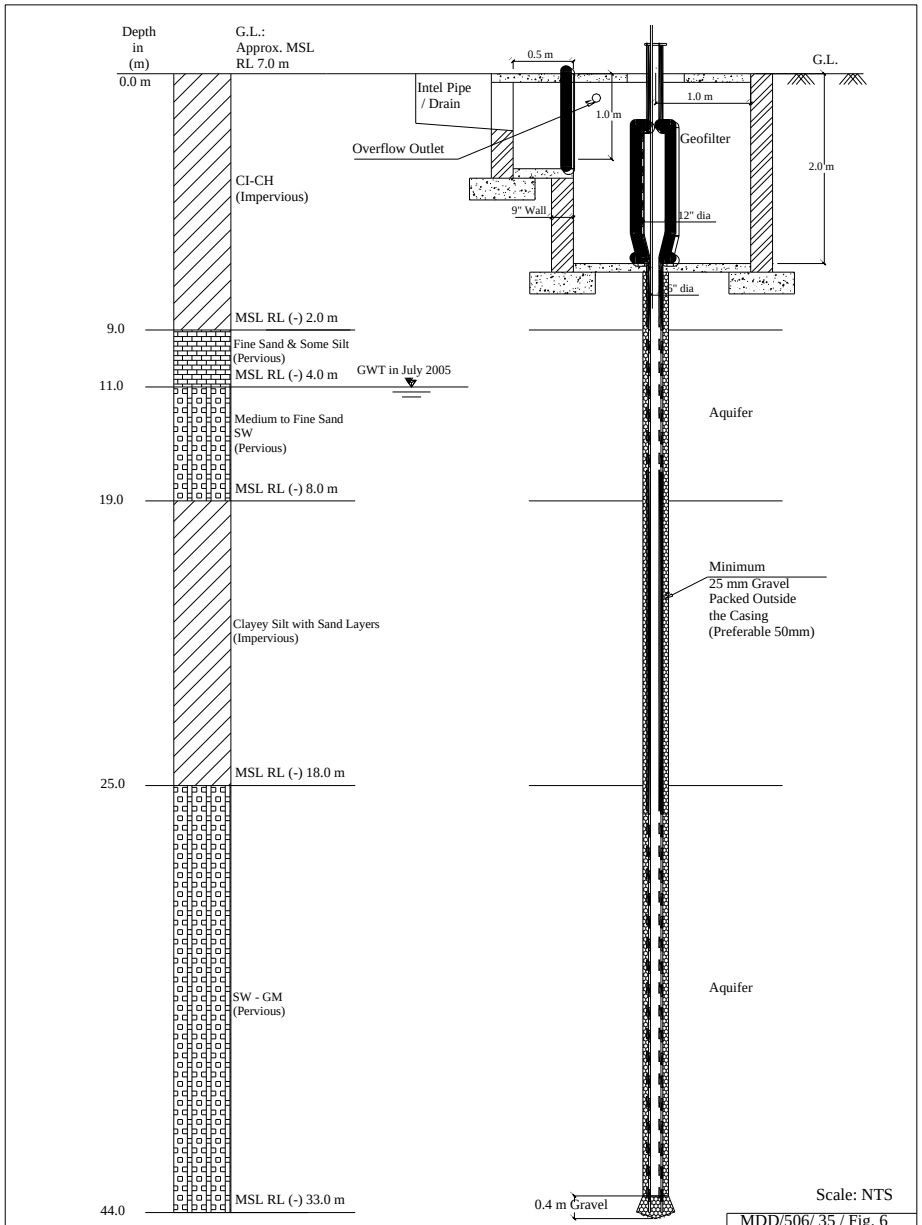
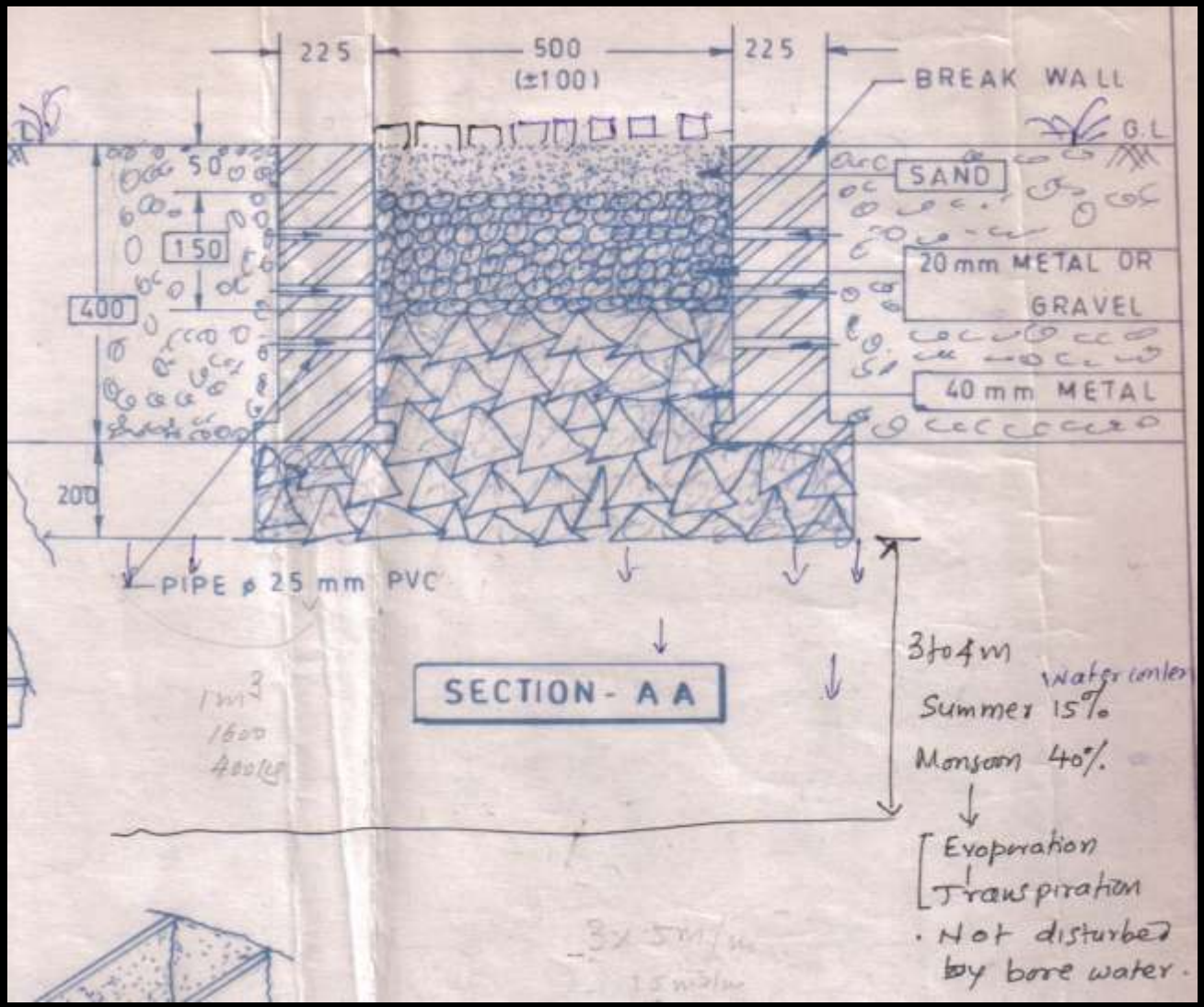


Fig. 6: Typical Cross Section of Proposed Bore at full Depth at Gujarat Gas Compay, Adajan

SARJAN SOCIETY

UMRA, SURAT

No need of watering during the rainy days and then after 2 months for Garden in Sarjan Society, Umra, Surat.



૨ ગુજરાત સમાચાર, સુરત, બુધવાર તા. ૧લી મે ૨૦૦૨

ગ્રાઉન્ડ વૉટર રીચાર્જીંગ પદ્ધતિથી સોસાયટીમાં પાણીનું સ્તર ઉચુ આવ્યું

(પ્રતિનિધિ દ્વારા) સુરત, મંગળવાર

વધતી જતી વસ્તી અને વધતા જતા પાણીના ઉપયોગની સામે જળસ્ત્રોતની પ્રાપ્તીનું પ્રમાણ એજ રહેતા આગામી વર્ષોમાં કદાચ પાણી એ સમગ્ર વિશ્વ માટે સૌથી વિકરાળ સમસ્યા બની રહેશે ત્યારે કેટલાક ઠેકાણે ભવિષ્યને ધ્યાનમાં રાખીને પાણીનો સંગ્રહ કરવાની શરૂઆત કરવામાં આવી છે.

ડિસેમ્બરમાં જ્યાં બોરનું પાણી ખારું થતું હતું ત્યાં માર્ચ સુધી મીઠું પાણી આવી રહ્યું છે

દોઢેક વર્ષ અગાઉ પાલેપોઈન્ટ નજીક આવેલી સર્જન સોસાયટીના રહેવાસીઓ રસ્તા અને પાણીની સમસ્યાથી પીડાયેલા હતા. ખાસ કરીને ચોમાસાના સમયે જ્યારે પુષ્કળ પ્રમાણમાં વરસાદ પડે છે ત્યારે સોસાયટીઓના રસ્તાઓ ઉપર પાણી ભરાય જાય છે, જેને કારણે દર વર્ષે આ સોસાયટીના પાકા રસ્તાઓ પણ ખરાબ થઈ જતાં હતા અને વરસાદનું પાણી બેટરમાં વહી જતું હતું. આમ પાણી તો વેડફાતું જ હતું, સાથે સાથે રસ્તાઓ પણ ખરાબ થઈ જતાં હતા. પરંતુ આ સોસાયટીના કેટલાક જાગૃત રહેવાસીઓ દ્વારા પાણીની બચત કેમ કરવી તેવો વિચાર આવ્યો અને આ ઉમદા વિચાર અમલમાં પણ મુકવામાં આવ્યો.

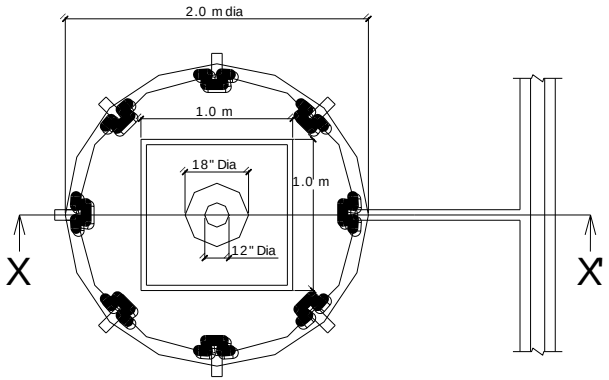
હાલમાં દોઢેક વર્ષ અગાઉ સર્જન સોસાયટીના રહેવાસીઓ દ્વારા જાણીતા ભૂતરશાસ્ત્રી પ્રો. મહેશભાઈ દેસાઈની મદદથી ગ્રાઉન્ડ વોટર રીચાર્જીંગ પદ્ધતિનો ઉપયોગ કરવામાં આવ્યો અને સોસાયટીના રસ્તાઓની બાજુમાં આવેલી ડ્રેઈન લાઈન ઉપર પાંચ જેટલા બોર બનાવવામાં આવ્યા. પ્રથમ વરસાદનું પાણી આ બોર દ્વારા ભૂગર્ભમાં ઉતારવામાં આવ્યું. પ્રો. દેસાઈના જણાવ્યા અનુસાર તેમણે સોસાયટીનો પ્રવાસી સ્થાનિક વ્યક્તિઓ સાથે વાતચીત કરી હતી. તેમણે જણાવ્યું કે અગાઉના વર્ષોમાં આ સોસાયટીમાં નવેમ્બર-ડિસેમ્બર મહિનામાં બોરના પાણીમાં ખારાશ આવી જતી હતી. પરંતુ આ પદ્ધતિ અમલમાં લાવ્યા બાદ માર્ચ સુધી પાણીના ટેસ્ટમાં ખારાશ લાગતી નથી. એટલે કે આ પદ્ધતિ અમલમાં આવ્યા બાદ ખૂબ જ ઓછા પ્રમાણમાં વરસાદી પાણીનો ભૂગર્ભમાં સંગ્રહ કરવામાં તેઓ સફળ નીવડ્યા છે.

આ ઉપરાંત સોસાયટીમાં આવેલી લોન મેઈન્ટેન કરવા માટે દર વર્ષે જેટલા પાણીનો ઉપયોગ થતો હતો તેના કરતાં ખૂબ જ ઓછા પાણીથી આ વખતે લોન મેઈન્ટેન થયો કારણ કે જમીનમાં પાણી ઉતરવાને કારણે જમીન અંદરથી પણ ભેજવાળી થઈ છે. પાંચથી છ વર્ષની અંદરે પાણીનું લેવલ ચાર ફૂટ જેટલું ઉચુ આવે તેવી શક્યતા છે. આ ઉપરાંત વરસાદી પાણી વહીને ભૂગર્ભમાં જતું હોવાને કારણે દર વર્ષે રસ્તાઓ તૂટી જવાની જે સમસ્યા છે તેનાથી પણ તેઓ મુક્ત થાય છે.

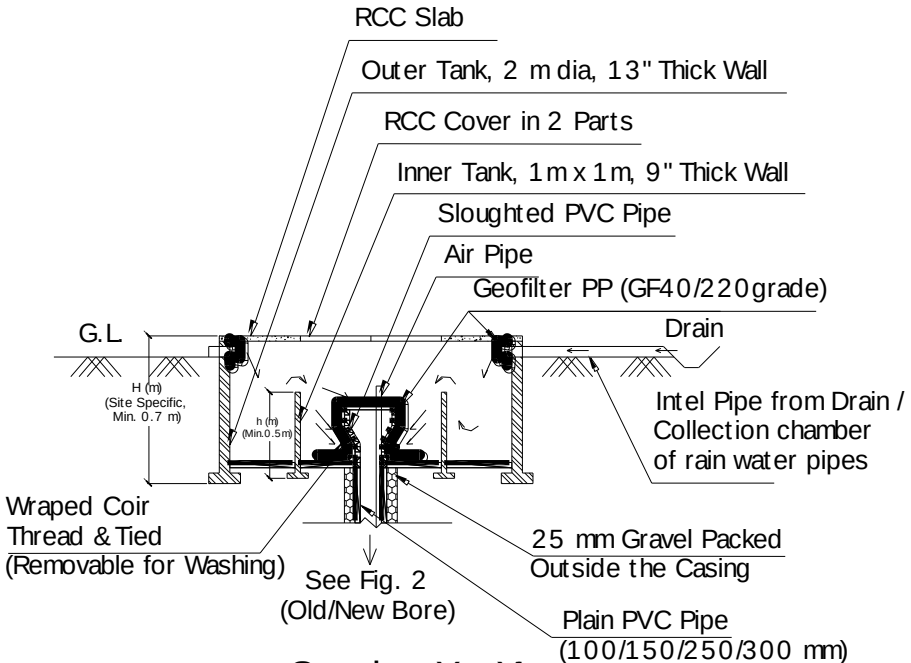
જો શહેરની અન્ય સોસાયટીઓમાં પણ આ પદ્ધતિનો અમલ કરવામાં આવે તો આગામી વર્ષોમાં આવનારી પાણીની સમસ્યાને પહોંચી વળવા માટે લોકો ઓછેવત્તે અંશે સક્ષમ થઈ

BOTANICAL GARDEN

SURAT



Plan



Section X - X'

Fig. 1: Plan & Section of Proposed G W Harvesting System at Botanical Garden, Surat.

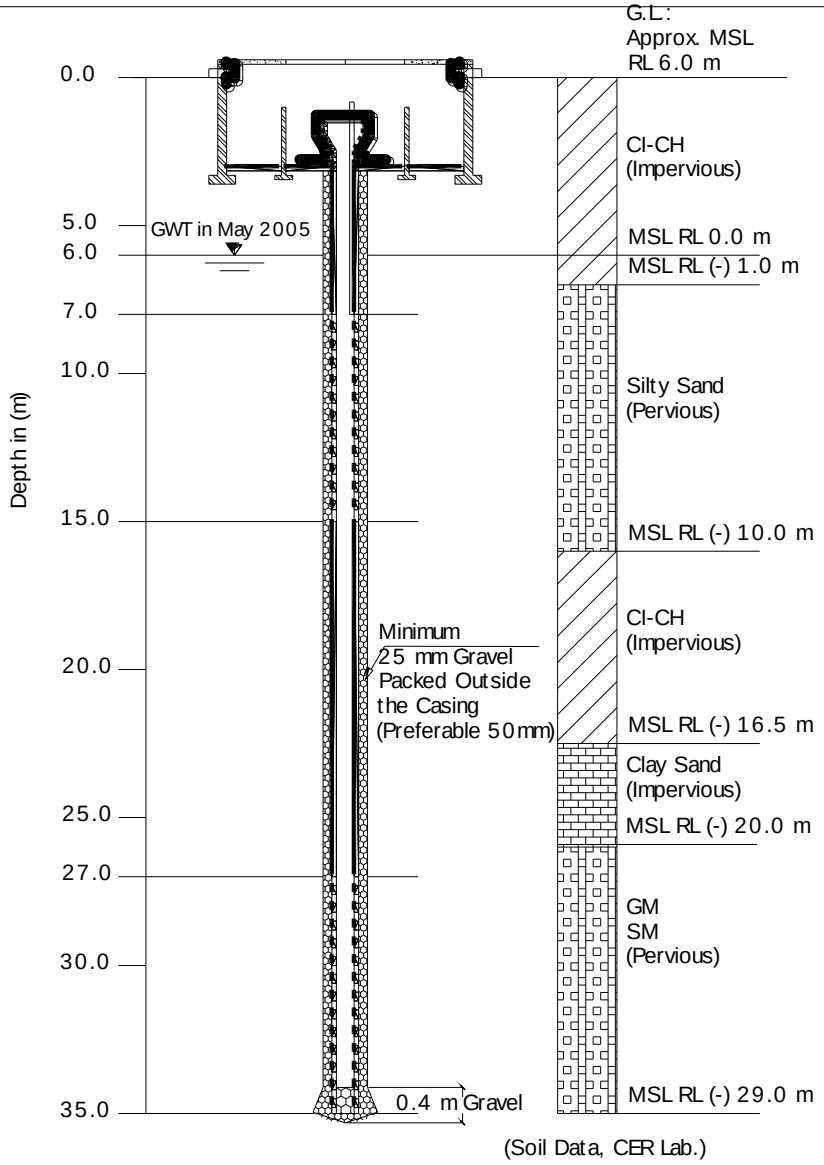


Fig. 2: Typical Cross Section of Bore at full Depth at Botanical Graden, Surat

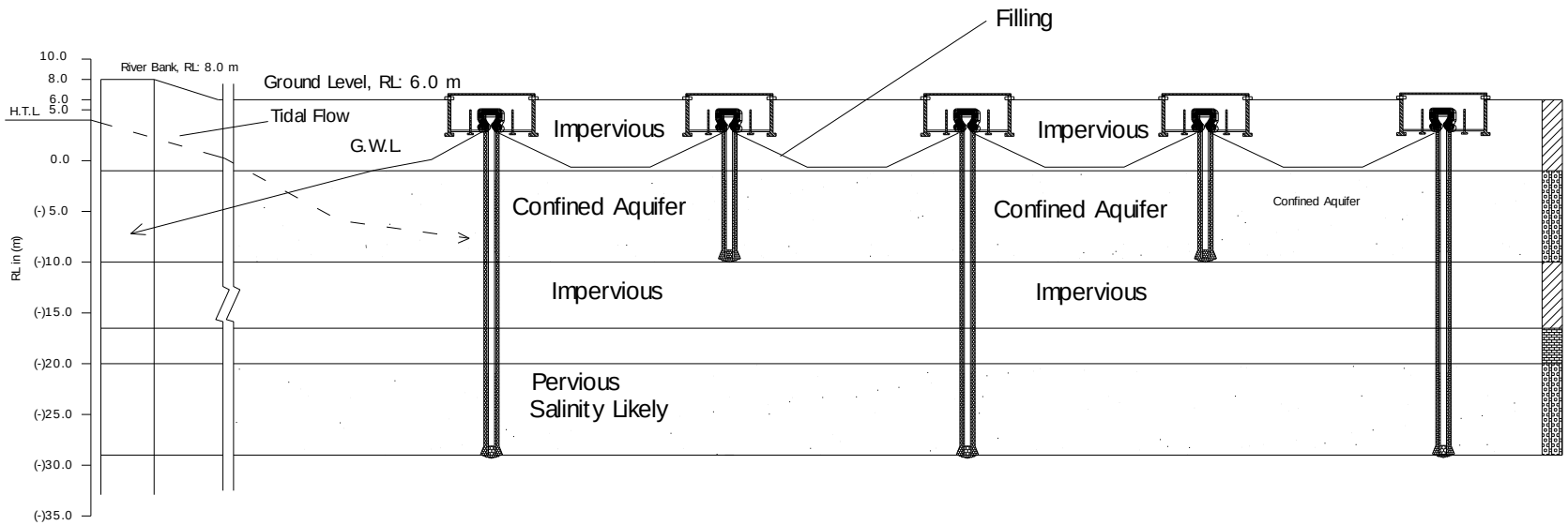
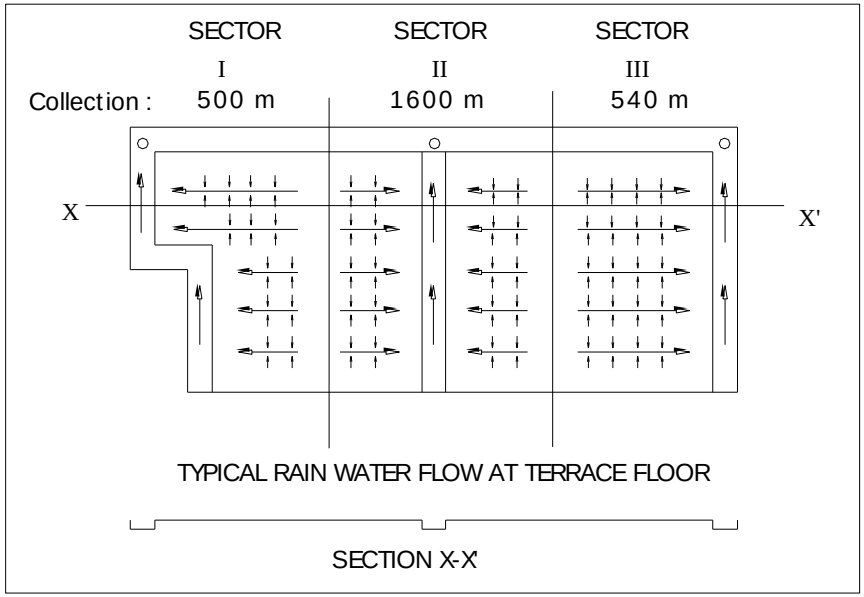
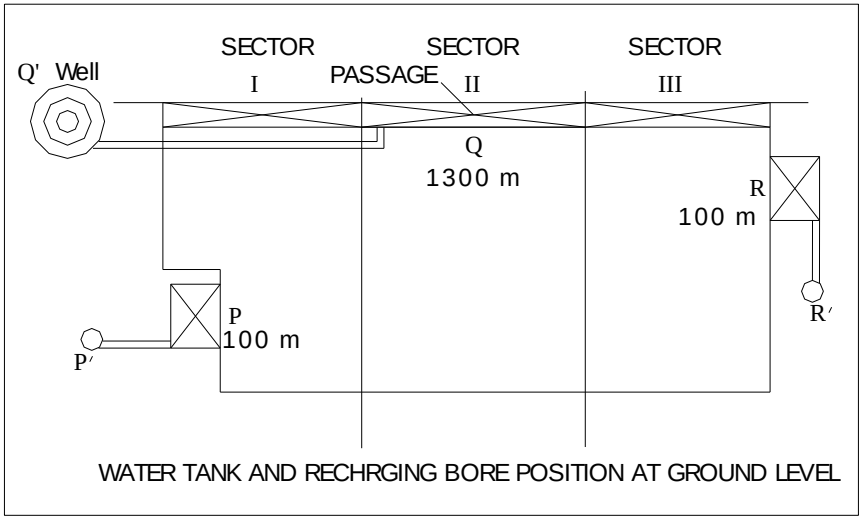


Fig. 3: Differntial Level G W Harvesting Scheme at Botanical Garden, Surat.

RADHA KRISHNA TEXTILE MARKET

RING ROAD, SURAT


SECTOR I
SECTOR II
SECTOR III
Collection :
500 m
1600 m
540 m
X
X'
TYPICAL RAIN WATER FLOW AT TERRACE FLOOR
SECTION X-X'


SECTOR I
SECTOR II
SECTOR III
Q' Well
PASSAGE
Q
1300 m
R
100 m
R'
P
100 m
P'
WATER TANK AND RECHRGING BORE POSITION AT GROUND LEVEL

KAVI KALAPI GARDEN

ADAJAN, SURAT


More...
Map
Satellite
Terrain
200 ft
50 m
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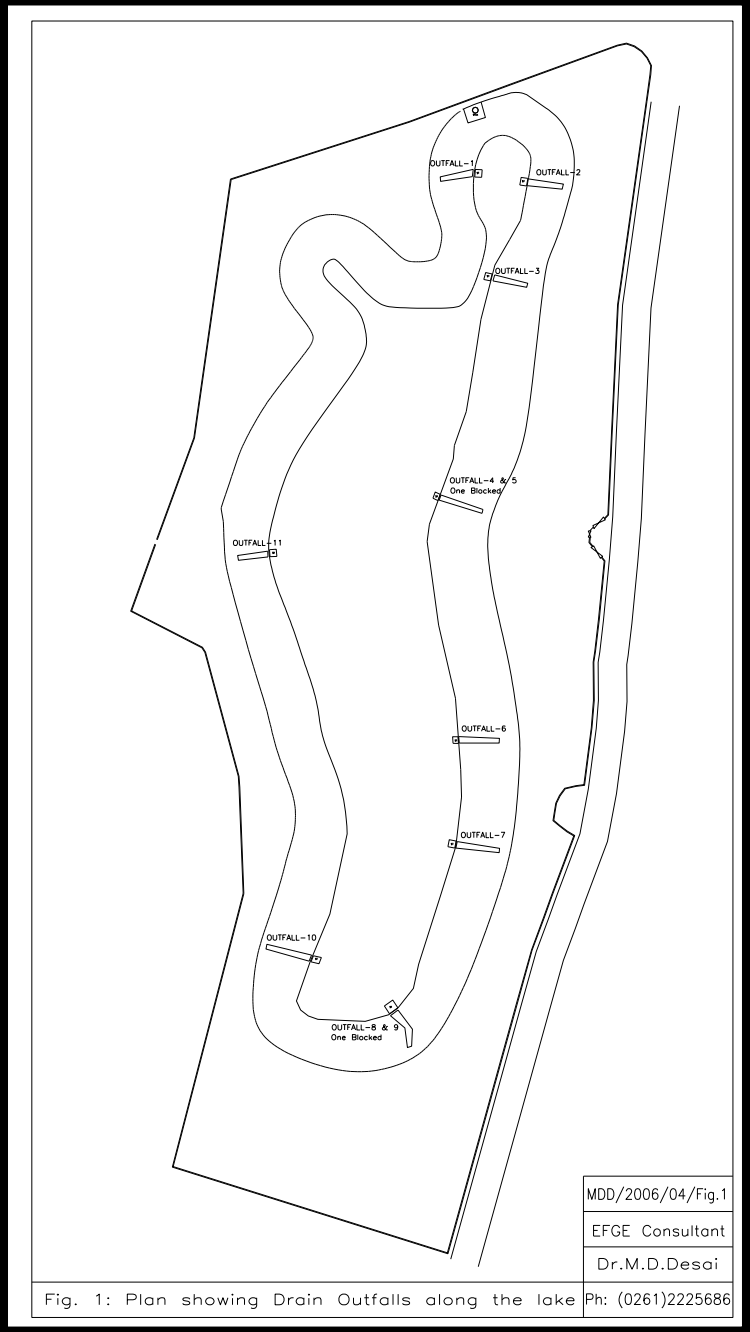
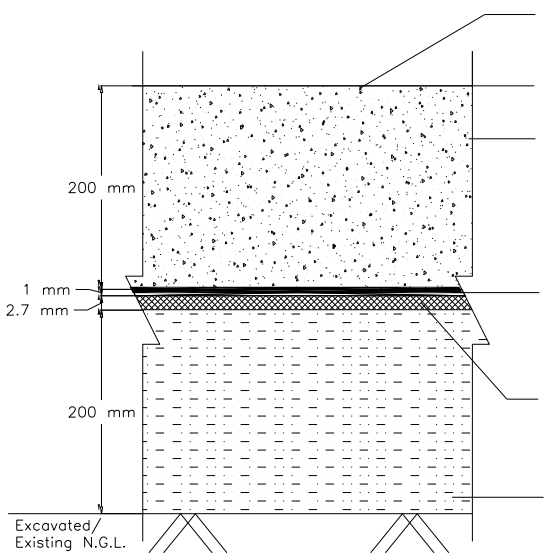


Fig. 1: Plan showing Drain Outfalls along the lake



White coat polymer paint (See Specificatoin 5)

Cement concrete 1 : 5 : 10
(1 PPC cement : 5 fine sand : 10 hand broken stone aggregate 40 mm nominal size) (See Specificatoin 4)

2164 HDPE Carbolock HDPE 2/30/120 or HDPE 3/30/140 of Garware wall ropes Ltd. (Raise 0.5 m on sides)
(See Specificatoin 3)

Non–woven geotextile 340 ± 5 g/sqm with overlap 0.3 m
(Raise 1.0 m on sides) (See Specificatoin 2)

Layer of rammed stabilized soil, 200 mm thick.
(See Specificatoin 1)

CLAYEY SOIL

	MDD/2006/04/Fig.2
	EFGE Consultant
	Dr.M.D.Desai
Fig. 2: Typical Cross Section Showing Proposed Water Prof Lining at Kavi Kalapi Garden lake	Ph: (0261)2225686

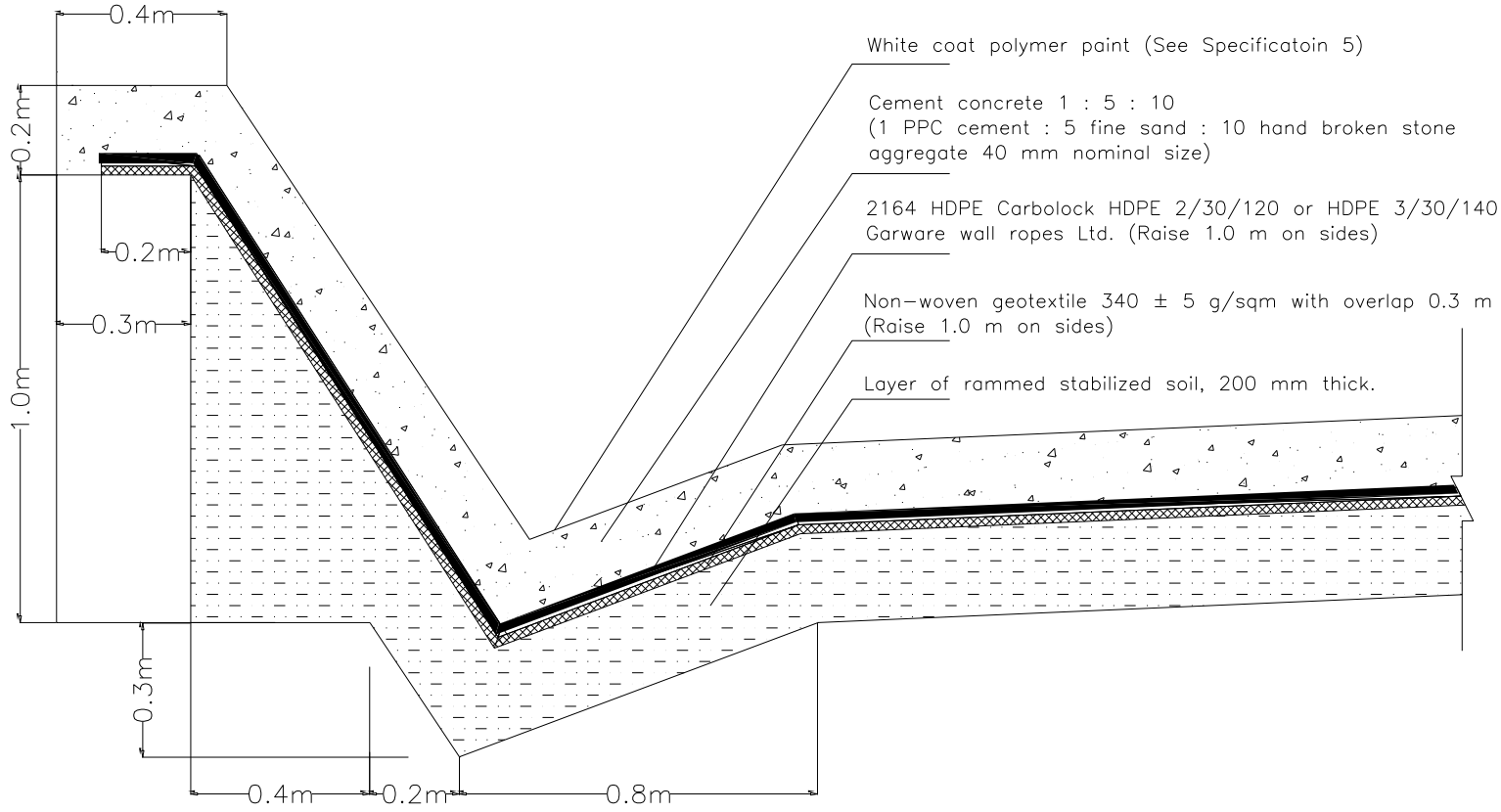


Fig. 3: Typical Cross Section showing proposed Sump along the toe wall in Kavi Kalapi Garden lake

MDD/2006/04/Fig.3

EFGE Consultant
Dr.M.D.Desai
Ph: (0261)2225686

Other Case Studies of Rainwater Harvesting by Bores 10 to 15 M.

(Since 1994)

Sneh Smruti (2002),

Centre of Social Studies,

Jain Temple, Magdalla,

Khatiwala School, Rundh, Surat

Example to Explain Economics of the Rainwater Harvesting for New Developing Township:

1. Plot area of Township = 100 ha.
2. Population density = 50 ppha.
3. Population to be served = 5000 persons
4. Water requirement = 1500 cu.m per day = 5.5 x 10^5 cu.m. per year (Considering 300 lpcd, higher value for water usage in gardening, cleaning etc)
5. Estimated Cost of water from private source = Rs 550 lakhs per year (Considering Rs 100/- per cu.m of water)

EXPENSES:

Daily maximum runoff from terrace = 1,50,000 cu.m per day (Considering storm of 100 mm / hr for 3 hrs or 300 mm per day maximum)

Recharging module requirement:

Design the recharging system for half the max. runoff = 75,000 cu.m per day

No. of Bores with 10 m^3/hr recharging capacity = 200 nos

No. of wells with 30m^3/hr recharging capacity = 35 nos.

Cost of recharging system:

Cost of Bores = 200 nos x Rs 50,000/- per bore
= 100 lakhs

Cost of Wells = 35 nos x Rs 2,00,000/- per well
= 70 lakhs

Cost of other peripherals requirement = 30 lakhs

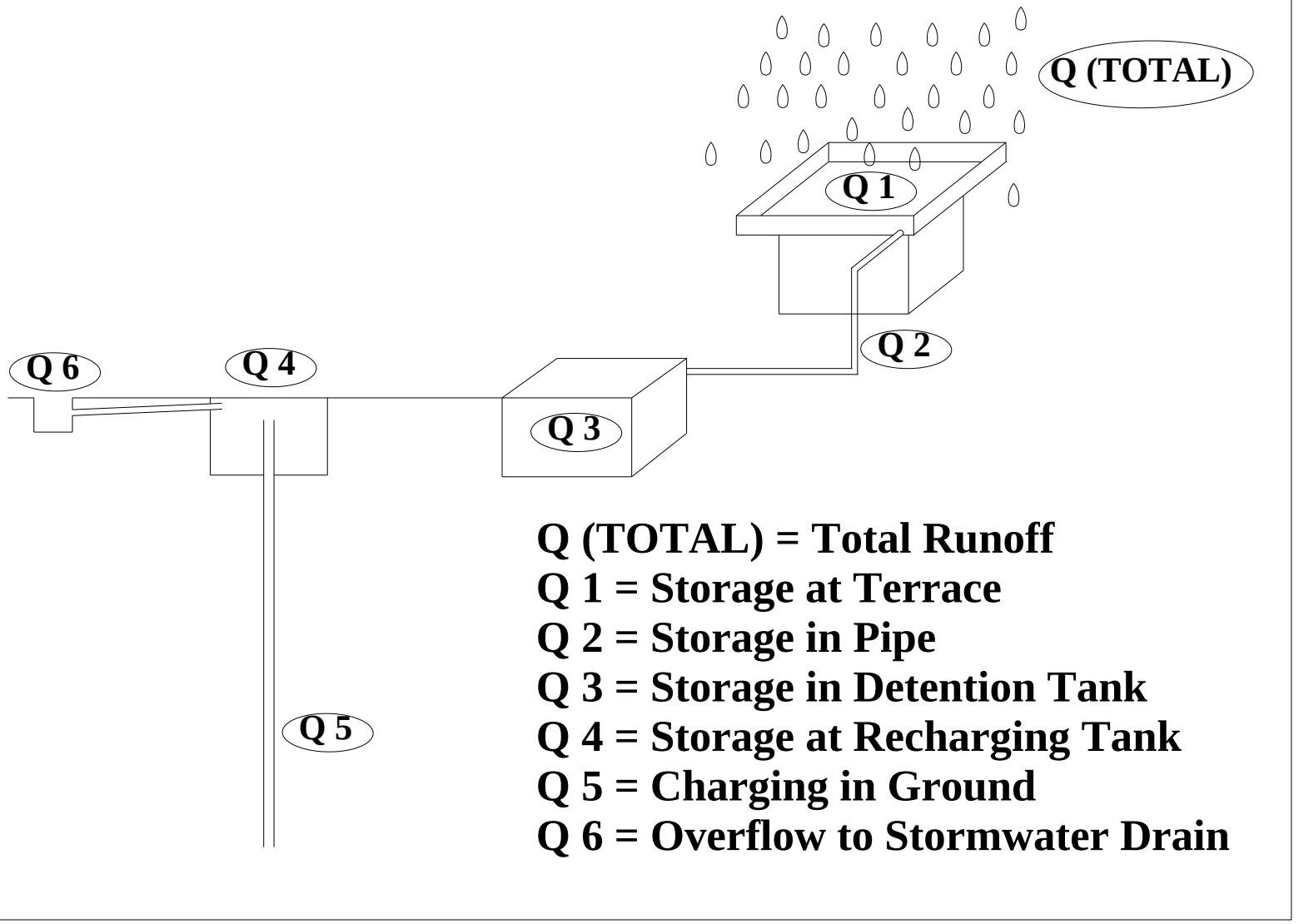
Total Cost of recharging system = 200 lakhs

EARNINGS:

Total water collected from terrace for harvesting
= 7.5 x 10^5 cu.m per year

TOTAL COST OF WATER HARVESTED = 750 LAKHS PER YEAR.

These shows that with Capital Investment of Rs 200 Lakhs + Rs 50 Lakhs Maintenance per Year can also be Economically Feasible with the saving in Water Cost of Rs 750 Lakhs Per Year



Q (TOTAL) = Total Runoff
Q 1 = Storage at Terrace
Q 2 = Storage in Pipe
Q 3 = Storage in Detention Tank
Q 4 = Storage at Recharging Tank
Q 5 = Charging in Ground
Q 6 = Overflow to Stormwater Drain

Sketch showing the Water quantity calculation for Recharge system.

THANK YOU